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PLANT DISEASES.—Pages 188-206.

WEEDS.—Pages 206-210.

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BULLETIN 136.—ABSTRACT TWENTIETH ANNUAL REPORT, 1906-7
PLANT DISEASES, WEEDS, HORTICULTURE, INSECTS

JOSEPH L. HILLS

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INTRODUCTION

Following the precedent established four years ago, abstracts of the twentieth annual report are presented in this bulletin and the succeeding number in which the matters of more direct practical interest are briefed. Recipients of either bulletin desiring to receive the full report have but to ask, specifying by its number—twenty.

The twentieth report marked the close of as many years of station existence. Since preceding issues are mostly out of print, but frequently called for, it seemed both desirable and appropriate to gather therein brief resumés of such studies as possessed more than ephemeral interest. In the two abstracts presented are statements:

No. 136—Concerning plant diseases, weeds, horticulture, insects and insecticides.

No. 137—Concerning crops, stock feeding, and dairy husbandry.

The writer is responsible for the editing of the briefed matter. The articles to which authors' names are attached are condensed from the new matter appearing in the twentieth report. The material as printed in the report which is condensed from previous publications shows authors' names and gives references to the original publications. Owing to exigencies of space only the barest outlines are given.

THE OCCURRENCE OF PLANT DISEASES IN 1907

N. J. GIDDINGS

The wet, cloudy weather of the spring and early summer favored the development of many plant diseases. Other maladies, however, received a severe set-back in late July and August, when hot, dry weather ensued. The rainy weather of September revived some dor mant parasites, but they did not cause much damage.

POTATO DISEASES

Insect injuries.—The Colorado beetle and flea beetle were very destructive where not properly held in check. The former is easily controlled by paris green, but the latter is not thus appreciably affected. The bordeaux-paris green combination, however, was very effective in combatting both beetles.

A large number of seedling plants were destroyed by wire worms, the entire base of the stalk being perforated.

The amount of tip-burn was unusually large. It usually results from a long, hot, dry spell. Working in conjunction with the early blight and flea beetle it caused considerable loss during the drouth of last midsummer. Plots sprayed with bordeaux mixture showed much less of this trouble than did other plots.

Early blight.—This disease was quite destructive. The dry weather of midsummer favored its development, especially on sandy soils. On many fields one-sixth of the total active leaf surface was thus destroyed. Since diminution of the living leaf surface proportionately reduces the tuber yield, the early blight caused much loss in 1907. Spraying with bordeaux mixture proved a quite effective check to this trouble. There were only one-third to one-half as many badly diseased leaves this year on the bordeaux plots as on the check plots.

Leaf blotch.—This disease was described in detail in the 19th report. It was found again in 1907, a severe outbreak occurring near the Experiment farm on a field where a few diseased leaves were noted in 1906. Potatoes were again planted in this field in 1907 and a great many leaves were practically covered with the leaf blotch fungus, as were likewise the leaves of a weed found growing in a thicket remote from tilled land, an occurrence which raises the question as to whether the fungus, hitherto assumed to be introduced from Europe, may not be native.

Late blight.—The late blight fungus did but little damage in this immediate vicinity. The September rains, however, favored its development and a considerable loss occurred in central Vermont

nearer the mountains, and in other states the disease caused great loss. Favorable weather conditions next year will insure its destructive development where potatoes are not properly sprayed. Bordeaux mixture is the best known preventive preparation.

Scab was prevalent in many fields. Planting in new soil and disinfecting tubers with formalin just previous to planting are found effective methods of control.

Black leg.—Several tubers taken from diseased hills in 1906 were planted on a sandy loam in 1907. They made normal growth, but showed no disease. Some Beauty of Hebrons immediately adjoining these, however, showed several hills affected with "black leg." The latter seed was bought of a local dealer. Two other varieties in the same field showed no traces of the malady. Reports were received of black leg from Maine and Massachusetts. Specimens secured from Maine resembled in appearance those collected here. A Massachusetts correspondent states that the disease occurs with him most frequently with new seed, and that he rarely finds any the second year after such introduction. It is not easy to reconcile these conflicting observations. The writer inclines to the belief that it is apt to be carried on or in the tubers, but that soil conditions determine its destructive development.

ORCHARD DISEASES

Apple canker is still prevalent and is easily controlled by pruning and spraying.

Black knot of plum was more destructive than usual, the fungus being favored by the long continued spring rains. The disease is easily held in check by proper pruning and spraying.

Brown rot of the plum caused considerable loss among susceptible varieties. Wherever the plums hang in clusters touching one another, rot development is favored. The spores are washed down in rains and any which chance to lodge between two plums that touch are apt to be held there, and to find conditions favorable to growth. If one plum of a cluster is seen to be diseased it should be destroyed at once, as others in the cluster are almost sure to go if the rotting one hangs long in contact with them.

GARDEN DISEASES

Club root.—This disease was widespread, as usual. It troubles market gardeners in various portions of the State, and must continue to increase until greater care is taken to prevent dissemination. Cabbage plants should be started in soil which has not been previously used for cabbage culture. A field in which the disease is found should

be kept free of cabbage, turnip, and kale, and other weeds of the mustard family for several years, since the fungus lives over in the soil and thrives on any plants of this family.

Muskmelon anthracnose.—This disease did considerable damage in market gardens, the September rains favoring its spread. This trouble is present more or less every year, but the loss is generally small. Spraying with bordeaux mixture about July, and every two weeks thereafter until late August, is effective in its control.

A *muskmelon rot* of a bacterial nature attacked experimental melons, but does not appear to have been widespread.

FOREST DISEASES

Pine blight, an obscure disease of the white pine, has been prevalent for several years past. Its cause is as yet undetermined, but is being investigated by the Bureau of Plant Industry of the United States Department of Agriculture.

POTATO SPRAYING EXPERIMENTS

L. R. JONES AND N. J. GIDDINGS

Experimental trials of fungicides upon potatoes have been carried on for 17 years. Those of 1907 were designed to show:

I. The gain from spraying with bordeaux-paris green and the comparative results from 2, 3 and 4 applications.

II. The gains from commercial compounds (Boxal and Bug Death) as compared with bordeaux mixture and paris green.

THE GENERAL PLAN OF THE EXPERIMENTS

These experiments were conducted on a level sandy loam fairly uniform in its character. The trials were planned primarily to test fungicidal values; but certain insects and fungi come at about the same season and it is often impracticable to tell the gains due to fungicidal effects from those due to insecticidal or other action. All held the Colorado beetle in check. Flea beetles were present as usual and did considerable damage where not controlled. Much of the difference in results is due to the greater or less control of these pests.

The early blight fungus occurred destructively and distinct evidence was obtained as to the fungicidal value of the various compounds as against this malady. The late blight fungus was not found, and none of the gains can be attributed to its control; and there was no rot whatever in the tubers.

THE GAIN FROM THE USE OF BORDEAUX MIXTURE

Trials have been made since 1891 to determine this matter. Bordeaux has shown beneficial effects as a fungicide, an insecticide and as a tonic. These factors vary from year to year, therefore the results vary; but in every trial spraying has proved distinctly beneficial. The bordeaux used was made of 5 pounds copper sulphate, 5 pounds lime and 50 gallons water, and mixed fresh. To this was added one-half pound paris green for all applications, except the last (August 22). 150 gallons per acre were used twice and 200 gallons, twice. The control rows were poisoned at the same dates with paris green alone, mixed with slaked lime, one pound poison to 20 pounds lime, 30 pounds per acre being applied. Green Mountain potatoes, planted May 25, were used.

Plot 1. Bordeaux applied four times, July 16 and 25, August 8 and 22.
Plot 2. Bordeaux three times, July 25, August 8 and 22.
Plot 3. Bordeaux two times, August 8 and 22.
Plot 4. Control, paris green in lime.
Plot 5. Bordeaux four times, July 16, 25, August 8, 22.
Plot 6. Control, paris green in lime.
Plot 7. Bordeaux three times, July 25, August 8, 22.

Paris green was applied at the earlier dates on plots 2, 3 and 7, to check the Colorado beetle. The beneficial effects of bordeaux were seen in early August and were increasingly evident later on. This was the more noteworthy since there was no trace of late blight; the benefits being due to the control of early blight and insect troubles, save in so far as the less definite physiological effects were of help. The latter were operative, however, as shown by the relatively richer green of the sprayed foliage and the lessened amount of tip-burn.

In order to get definite data as to the relation of spraying to flea beetle and early blight injuries, critical examinations were made September 6. Typical plants were selected in each plot and counts made of those leaflets badly blighted and of those severely punctured by flea beetles. Averages were as follows:

	Leaflets badly eaten by flea beetle	Leaflets badly diseased with early blight
Bordeaux twice, Aug. 8, 22	95%	75%
Bordeaux three times, July 25, Aug. 8, 22	55	45
Bordeaux four times, July 16, 25, Aug. 8, 22	48	40
Paris green in lime	97	80

The results are striking and conclusive. The August 8 and 22 applications were ineffectual to a large degree. The July sprayings were the ones which chiefly prevented these two pests from obtaining their foothold in the field.

The yields per plot are shown herewith:

		Large tubers Pounds	Small tubers Pounds	Total yield Pounds	Gain in market'le tubers over check Pounds	Percent
Plot 1.	Sprayed four times.....	218.8	41.6	260.4	138.8	172.5
Plot 2.	Sprayed three times.....	158.4	47.6	206.0	78.4	98.
Plot 3.	Sprayed two times	154.3	51.8	206.1	74.3	92.9
Plot 4.	Check paris green.....	80.0	56.9	136.9	.....	.....
Plot 5.	Sprayed four times.....	165.1	50.4	215.5	79.8	93.5
Plot 6.	Check paris green.....	85.3	59.5	144.8	.....	.....
Plot 7.	Sprayed three times.....	130.0	56.3	186.3	44.7	52.4

The gain in plot 1 over 2 was 26%, and in plot 5 over 7, 16%. Under the conditions of 1907 the first spraying (mid-July) was important. Probably three thorough sprayings made about July 15, August 1 and August 15, would have done as well as four. The first application of bordeaux should be made about mid-July. Since most potato sprayers apply only 50 or 75 gallons per acre, one must go over the rows twice to secure as thorough an application as is here recommended and practiced. If this is done a 2 or 3 week interval may elapse between dates of spraying. In actual farm practice, however, it will probably prove better to use the single lighter application and to go over the field more often, i. e., once in a week or ten days. Thus if the first spraying was made the second week in July, four or five such applications would be advisable. If, however, a period of moist, warm weather intervenes and the late blight threatens, it is advisable to make a thorough application, using at least 150 gallons per acre. With ordinary spray carts it might be necessary to go over each row twice, making the second application in the opposite direction from that of the first, so as to cover the foliage more effectually.

The results are entirely in harmony with those of preceding years. Some years the gain is large, in others it is smaller; but in any case it pays to spray and so to insure a full crop.

GAINS FROM THE USE OF BORDEAUX MIXTURE ON LATE POTATOES

Planted	Sprayed	Yield per acre		Gain per acre
		Sprayed	Not sprayed	
White Star,				
May —, 1891	Aug. 26, Sept. 8,	313 bu.	248 bu.	65 bu. or 26 %
May 20, 1892	July 30, Aug. 13, 25,	291 "	99 "	192 " " 194 "
May 20, 1893	Aug. 1, 16, 29,	338 "	114 "	224 " " 196 "
Apr. 26, 1894	June 16, July 17, Aug. 30,	323 "	251 "	72 " " 29 "
May 20, 1895	July 25, Aug. 13, 31,	389 "	219 "	170 " " 78 "
Polaris,				
May 15, 1896	Aug. 7, 21,	325 "	257 "	68 " " 26 "
June 1, 1897	July 27, Aug. 17, 28,	151 "	80 "	71 " " 89 "
White Star,				
May 10, 1898	July 21, Aug. 10,	238 "	112 "	126 " " 112 "
Average,				
3 varieties,				
May 18, 1899	July 26, Aug. 17, Sept. 8,	229 "	161 "	68 " " 42 "
Delaware,				
May 23, 1900	Aug. 4, 23,	285 "	225 "	60 " " 27 "
May 25, 1901	July 20, Aug. 21,	170 "	54 "	116 " " 215 "
May 15, 1902	Aug. 1, 20,	298 "	164 "	134 " " 82 "
Green Mountain,				
May 1, 1903	Aug. 10,	361 "	237 "	124 " " 52 "
Delaware,				
May 25, 1904	Aug. 1, Sept. 1,	327 "	193 "	134 " " 69 "
May 15, 1905	Aug. 2, 21,	382 "	221 "	161 " " 73 "
Green Mountain,				
May 27, 1906	Aug. 13, 22,	133 "	101 "	32 " " 32 "
May 1, 1907	July 16, 25, Aug. 8, 22,	171 "	63 "	108 " " 175 "
Average of 17 years,		278 "	165 "	113 " " 68 "

A COMPARATIVE TRIAL OF BOXAL, BUG DEATH AND BORDEAUX-ARSENICAL MIXTURE

Numerous inquiries have come as to the value for use on potatoes of the commercial preparations known as Boxal and Bug Death. Trial plots of 10 rows each were therefore laid off for treatment as follows: Two rows Bug Death, two rows Boxal, two rows bordeaux mixture, four rows paris green. The bordeaux was of the 5-5-50 formula and one-half pound paris green was added to 50 gallons. The first three applications were 150 gallons per acre and the last two, 200 gallons. The control plot received paris green in lime, 1 to 20, at the rate of 30 pounds per acre. The Bug Death and Boxal were mixed with water at the rate of one pound to 10 gallons. It seems necessary to apply Bug Death liberally to keep the plants free from Colorado beetles, and 25 pounds

to the acre of Bug Death and 19 pounds to the acre of Boxal were used. The primary aim was to test the relative efficacy of these compounds against the other insects, chiefly flea beetles, and as fungicides and general tonics. Hence liberal applications were continued through the summer, regardless of the special need so far as concerned the simple control of the Colorado beetle. All the preparations were applied five times at the following dates: July 9, 15, 26, August 8, 22. A marked beneficial effect was apparent during late August and September on all the plots treated with the spray compounds over the check plots. This effect, however, was much more apparent on the bordeaux plots than on any of the others. On September 6 leaflet counts were made to determine approximately the relative damage by flea beetle and early blight, with results as follows:

Treatment	Leaflets badly punctured by flea beetle	Leaflets badly diseased by early blight
Bug death	52 percent	47 percent
Boxal	60 "	60 "
Bordeaux	37 "	32 "
Paris green and lime	95 "	88 "

The Boxal and Bug Death are quite effective in checking the flea beetle and early blight, the early blight to a somewhat less degree than the flea beetle. Bordeaux was much more effective than either for controlling both the flea beetle and early blight.

On September 30 a count was made of those plants which still had living leaves, and so gave promise of further tuber formation, with results as follows:

Bug death	17 percent of plants alive
Boxal	4 " " " "
Bordeaux	68 " " " "
Check (paris green)	0 " " " "

These figures show a considerable range of difference, but the important point is that the plants sprayed with bordeaux carried much more living leaves than those treated otherwise. At the time of digging (Oct. 11) the plants were all dead in every plot except those treated with bordeaux. The following table gives the yields:

AVERAGE YIELD OF TUBERS OF MARKETABLE SIZE

	Yield of large tubers	Gain over check	Loss when compared with bordeaux
Boxal,	144.1 lbs.	50.5 lbs.=54 %	22.4 lbs.=13.5%
Bug death	127.0 lbs.	33.4 lbs.=35.6%	39.5 lbs.=23.7%
Bordeaux-arsenic	166.5 lbs.	72.9 lbs.=77.9%	.....
Check (paris green)	93.6 lbs.	.....	72.9 lbs=43.8%

Bug Death and Boxal are preferable to lime and paris green, but neither is as good as freshly prepared bordeaux-arsenical mixture. Both have insecticidal and fungicidal value, but are more costly and less effective than bordeaux.

POTATO DISEASES AND THEIR REMEDIES

Sundry forms of potato foliage disease commonly confounded under the general term "Blight." It used to be held that potatoes suffered from but a single malady, a "blight" or "rot." At least four distinct causes of the premature dying or blighting of the potato leaves are now recognized other than the weakening caused by potato or flea beetle attacks, viz.: late blight, early blight, arsenical poisoning and tip burn. These different maladies are distinctive and may be recognized as follows:

Late blight. A sequel of moist, warm, muggy (usually August) weather. Usually spreads quickly; leaves become black and drooping with offensive and characteristic odor; or may appear as purplish or brownish black spots; fungus is seen as a delicate white mildew on the under side of the leaf.

Early blight. Usually occurs soon after blossoming period; spots irregularly distributed over the leaf, at first small; as spots enlarge, tips and margin tend to roll up. Slower as a rule than late blight, and possessing no such characteristic odor.

Arsenical poisoning. Spots occur shortly after paris green application; traces of poison may be seen in the center of the spots; plants put out new unspotted leaves; spots apt to originate at flea beetle punctures and to show distinct target board like, concentric rings; color a metallic black to brown; no mildew on the spots.

Tip burn. The death of the leaflet at the margin and tip which dry, blacken, roll up and break off.

CAUSES AND PREVENTION. *Late blight.* A fungus (*Phytophthora infestans*). Clean seed; spraying with bordeaux, beginning before the disease appears.

Early blight. A fungus (*Alternaria solani*). Spraying with bordeaux before the disease appears.

Arsenical poisoning. Due to soluble arsenious acid. Use lime with paris green to neutralize the free acid.

Tip burn. Due to dry hot weather and too little water. Increase general vigor of plant.

Relation of time of planting potatoes to disease. Suggestions as to the relation of date of planting to the likelihood of success. "It

requires more expense and painstaking to care for early potatoes than to protect later ones." Planting about May 10-20 is suggested if one seeks the largest crop with the least work in protecting it, since it will thus escape the early blight so that spraying need not begin until about August 1. The date of planting should depend upon whether one is prepared or not to spray and also upon the conditions of weather which are to be expected.

Methods of preparing bordeaux mixture. Different bordeauxs look differently, show different color shadings, and settle out differently on standing. Properly made it has a peculiar deep blue color and its very fine precipitate should settle very slowly. The slaked lime may be kept as "stock" if covered with water. Such stock lime is preferable to poorly kept or partially slaked air lime. Copper sulphate may be kept in "stock solution" to be drawn upon as needed. The best results are most surely obtained if such stock solutions are much diluted before combining. One-half of the total amount of water should be used, in which case two-thirds of it may be added to the lime and one-third to the sulphate; but the latter should not be more concentrated. The details of their combination are important. The more quickly and thoroughly they can be mixed the better the result. Especial care is taken to avoid excess of free copper sulphate in any part of the mixture. Equally good results may be obtained:

1. By pouring the dilute lime milk quickly into the dilute sulphate solution and then stirring thoroughly.

2. By pouring the dilute sulphate solution quickly into the dilute lime milk and then stirring thoroughly.

3. By pouring the dilute sulphate solution slowly into the dilute lime milk and thoroughly stirring while adding.

4. By pouring the two together into a third vessel so that the two streams meet, stirring meanwhile until thoroughly mixed.

In all cases thorough and long continued stirring improves the mixture. The best procedure is No. 4, the next best, No. 3.

A gravity system. A lean-to shed served as a support to a two-tier stage or platform. On the upper platform were disposed the barrels for stock solutions of lime and copper sulphate, and, also, those in which these solutions were to be diluted preparatory to mixing in the third vessel on the platform below. These dilution vessels had faucets which were brought close enough together to allow the liquid flowing from both at the same time to be caught in a spout which emptied into the barrel on the lower level. The two solutions simultaneously flowing form bordeaux mixture during their flow into the

spout, the precipitate being extremely fine and passing through the cheesecloth strainer. The reaction takes place in the short spout and on the strainer and is continued by the agitation in the mixing barrel. The stock solutions only need be lifted.

Stock solutions. Much time may be saved if stock solutions are prepared. The formula used is the so-called 1-10 formula, that is, 1 pound of copper sulphate or of lime, as the case may be, to every 10 gallons of water. Hence in making up 50 gallons of bordeaux 5 gallons each of the stock solutions (1 pound per gallon) contained the required amounts of these ingredients. These are diluted to 25 gallons each, after which the faucets are opened and the whole process becomes self-operative even to the filling of the spray tank.

Does bordeaux mixture deteriorate on standing? A comparative trial with fresh and old mixtures; conditions otherwise being identical, showed 260 and 229 bushels potatoes per acre respectively when fresh and when old mixtures were used.

Improperly made bordeaux (concentrated stock solutions used instead of dilute ones) proved inferior, was more difficult to apply, needed more frequent agitation and was less adhesive than was a standard mixture.

Preparation and use of sprays. Spray calendar. A popular statement as to objects of spraying, spraying apparatus, formulas, directions for making insecticides, and a "spray calendar" indicating methods of combatting common fruit and vegetable garden pests.

Cost of spraying with bordeaux. What does it cost in materials and labor to spray an acre? No dogmatic answer can be given. Anywhere from 50 to 300 gallons may be needed; 50 gallons may suffice in mid-July and thrice that amount needed on the same piece in August. A half blighted piece in late August has received but 100 gallons and on the same day 250 gallons put on a luxuriant nearby growth. Weather conditions control. In 1891 and again in 1903 only a single spraying was necessary, in other years three have been needed. Speaking generally, however, three applications on medium potatoes planted in mid-May are needed; using 100 gallons in late July, 150 in mid-August and 150 in late August. At the time the article was written the weak bordeaux was figured to cost for materials about a cent a gallon. The cost of application naturally varies with apparatus, skill and vine growth. Three men, one horse, one barrel pump with convenient water, can spray an acre in two hours. The cost of three sprayings is figured at $7 per acre.

Number of times sprayed. Bordeaux was used July 30 and August 13 on part and July 30, August 13 and 25 on the rest of the piece. The gain from the third spraying was "one-third of the total gain." The thrice sprayed plants outlived those sprayed twice. Weather conditions control.

Two late applications (August 9, September 19) were inferior to three (July 21, August 9, September 9) because flea beetle and drought did very great damage before August 9. Nearly one-half the benefit was thus lost. Yet under the climatic conditions of the preceding year two applications—made say July 21 and August 10—would probably have insured nearly as large gains as three. Spraying should be begun in advance of the flea beetle attack. Whether one or two later applications are given should depend upon various conditions—variety, weather and the occurrence of diseases.

The first application (July 26) was the most important, one-half of the entire gain being attributable to it. The second and third were about equal in importance. Each was profitable, since it added 25 or more bushels an acre to the crop.

The next year a single spraying August 4 was the most effective. Those made before were of little avail; those made after did some little good. In deciding when to begin spraying one should use judgment which is only to be gained by experience. For early potatoes planted April to May 5, to spray July 1 and 15, August 1 and again if needed; for medium potatoes planted May 5-15, to spray July 15, August 1 and 15 and again if needed; for late potatoes planted May 15 or later, to spray August 1, 14, 28 and again if needed.

Gains from the use of bordeaux mixture on late potatoes. Experimental sprayings have been systematically made since 1891 and results stated yearly. Gains have always resulted, ranging from 32 to 224 bushels per acre. The 17-year table occurs on page 193.

Spraying as a remedy for early blight. Three and five applications of bordeaux mixture were made on six varieties in adjoining plots. The sprayed plots carried 331 and 316 bushels per acre, the unsprayed 169 bushels. The foliage on the unsprayed plots was from 15 to 90% killed on August 28. One-half of the gain in yield is attributable to the beneficial effects of the bordeaux in other ways than in checking the early blight, i. e., in deterring insects and promoting general vigor. Fully one-half was due to checking the early blight. The foliage was free from the late blight and there was no rot. It was a complete demonstration of the efficacy of bordeaux as a remedy for early blight when applied thoroughly and in season.

The effect of premature death of potato tops upon yield. The potato crop suffers more than is generally realized from the premature death of the vines due to some one or more of the forms of leaf injury. No tuber growth or increase in size takes place when the vines are dead.

Almost half of the money value of a potato crop is formed after September 1. How is it September 1 with unsprayed potatoes? Few are alive September 10, nearly all are dead August 20.

Will sun drying the tubers lessen rot? Two rows dug on a bright sunny day were in part thoroughly and long exposed to the sun, while the remainder were promptly gathered. Some gain resulted from exposure. If loss from rot is anticipated, exposure to sun and air before storage tends to its abatement.

Temperature of storage and rot development. Tubers were divided into three lots and stored at 70°, 50° to 55°, and at 40° F. for two months. The percentages of the crop unaffected were 31, 47 and 83. Potatoes were selling at 80-90 cents. The moral is obvious.

Relation of date of digging to development of rot. When potato tops are blighting is it better to dig at once or not? Four separate trials were made of this matter, covering several different varieties, locations, soil conditions, etc. The results during the first three seasons were in entire accord and led to the generalization that when potato tops have been killed by the late blight and there is danger of rot they should not be dug for a week or more after the tops were killed. Longer delay does not harm. With late varieties, where the disease progresses slowly, digging should delay until the third week of September at the earliest, and if practicable until after the tops are killed by the frost. During the last season the crop was grown on a heavy undrained clay loam ill adapted to potato culture, especially in the wet season which was experienced. These lost more when harvest was delayed than when it was prompt. This result led to the formulation of an exception to the rule quoted above. When potatoes are grown on a heavy wet soil in a wet season, they should be dug at once when the tops are blighted.

Disease resistance of potatoes. A study of the resistance of potato vines to blight, of potato tubers to rot, and of the tubers to scab. The following conclusions were drawn as a result of the work done in 1904:

"1. Some varieties are less subject to vine injury than are others.

2. Some show a greater tuber resistance to rot than do others.

3. With some there seems to be a fairly close relation between resistance of vine to disease and of the tuber to rot.

4. Selection has not given visible increase of resistance.

Hybridization and the growing of seedling plants followed by careful selection seem to offer a more logical method of securing disease-resistant varieties than does selection."

Further study in 1905 on two types of soil—using 154 varieties, about a hundred being of European and the remainder of American origin,—showed marked difference in the disease resistance of the several varieties, both as to leaf infection by late blight and to rot. In general, varieties having a strong, woody, moderately branched haulm and medium size rather than thick, more or less crumpled, firm, hairy leaves were found more resistant to disease, especially late blight, than were those possessing rather weak, partially woody, much branched, decumbent haulm with rather large, smooth, soft leaves.

The rot resistance of varieties of Dutch and German origin was superior to that of others, the average figures being: Holland 5.6, Germany 7.7, Scotland 18.5, England 18.1, France 32.2, American 37.6%. "American varieties have not thus far been bred for disease resistance." It was noted that while "disease resistance is important, commercial standards are based on prolificacy, appearance and edibleness, qualities in which the German and Dutch varieties are not pre-eminent, as judged by one year's trials and by American standards." These are not at present recommended to American growers.

Potato scab. Much work has been done on this malady. A popular presentation was made in bulletins 28 and 85—the latter of which may be summarized as follows:

This well-known malady is the result of a fungus infestation, which also causes scab on beets and possibly on the roots of other vegetables. It is probably not a native. Its germs occur in great numbers on scabby potatoes, and may cling to the surface of smooth tubers. Much of the loss from scab is directly due to the use of infected seed. When the fungus is not present in the soil a clean crop is assured if clean seed is used. Soil conditions may be favorable or unfavorable to its development. Certain varieties of potatoes are more liable to scab than others. Prevention or control should aim at the selection of resistant varieties, keeping the soil free from the fungus and disinfecting the seed potatoes. It is cheaper to abandon potato growing upon badly infected soil for a time than otherwise to combat the pest. If the soil is free from the fungus any method of fertilizing is safe, but if infected, alkaline fertilizers are to be avoided. Chemical disinfection of soil is not effective enough to warrant the cost. Seed potatoes are disinfected either by soaking one and a half hours in a solu-

tion made by dissolving 1 ounce of corrosive sublimate in 7 gallons of water; or by soaking two hours in a solution made by diluting one-half pint of formalin in 15 gallons of water.

Extensive trials in 1900 led to the statements that:

1. A scabby crop ensued when scabby seed was used on a scab free soil; that

2. A clean crop followed the use of a clean seed on clean soil; that

3. No seed disinfection availed if a badly infected soil were used; that

4. The fungus may persist in the soil for a long period of years, whether cropped with potatoes or not; that

5. While corrosive sublimate and formalin are both effective, the latter is more convenient and non-poisonous to stock; that

6. Formalin should be used but a day or two before planting; that

7. Corrosive sublimate, on the contrary, should be used two months before planting; that

8. Flowers of sulphur as a disinfectant or in the row proved ineffective; that

9. Exposure to sunlight for four weeks before planting greatly reduced the scab and hastened the growth of the tubers; that

10. Sulphurous gas used as a disinfectant gave indeterminate results; that

11. Formaldehyde gas proved superior to either corrosive sublimate or formalin.

APPLE, PLUM, OAT AND VEGETABLE DISEASES

Apple scab studies. The control of apple and pear scab has been studied for many years.

1895. "All the sprayed trees (of the previous year) were easily recognized by the cleaner and brighter color of the bark. The buds started earlier and more vigorously." Trees were sprayed four or five times with results as follows: 99% perfect scab-free fruit; only one scabby pear in six barrels where trees were sprayed five times, and but four in two barrels where the trees were sprayed four times. Practically every pear on unsprayed trees was scabby, 19% worthless for marketing, and 81% inferior to the sprayed fruit. The sprayed pears were valued in New York at $2.25, the best of the unsprayed fruit at $1.75. A barrel from the unsprayed tree was worth $1.42, from the sprayed tree, $2.23.

1897. Bordeaux used on Fameuse apples at Isle La Motte resulted as follows:

Sprayed	Selects.	No. 1.	No. 2	Cider apples
5 times	40%	20%	30%	10%
3 times	0	19	53	28
None	0	0	4	96

These apples were estimated at $1.60, $1.40, $1.00 and $0.15 per bushel, and the figures per tree, $15.44, $7.38 and $2.15 respectively. The need of the first and second applications is clear. It is not so clear that the fourth and fifth applications were profitable, but they probably were. In a dry season three or four applications are sufficient. Spraying meant practically the difference between a very profitable crop and a total failure in 1897. But it meant more than this, however. The fruit buds of 1898 were formed in 1897, and the fruit crop of 1898 is measured by the condition of the foliage in 1897. The enormous development of the scab fungus upon unsprayed trees in 1897 must shorten the crop of 1898; so the spraying of 1897 benefitted that year's crop and also that of years to come. The results of spraying are cumulative from year to year. The tree which is properly protected one year makes a stronger growth and a better crop in the next one.

1898. Further work in the same orchard gave the following data:

Sprayed	No. 1	No. 2	Cider apples	Value of crop
Paris green twice....	0%	40%	60%	$0.48
Copper sulphate once.	21	62	17	1.69
Do. + bordeaux once.	58	30	12	2.57
Do. + bordeaux twice	56	32	12	2.80
Do. + bordeaux thrice	67	22	11	3.56

"One cannot afford to grow apples for market without spraying, the gain depending on varieties, seasons and other conditions. The results are cumulative, so that after an orchard has been thoroughly sprayed for several seasons less spraying is required to hold the scab and other pests in check." An application of copper sulphate solution before leaves open and bordeaux-paris green before blossoms open, with one or two applications of latter after blossoms fall is advised for Fameuse.

Apple rust and cedar apples. The "cedar apples" of the red cedar are a fungus growth, their spores attacking the apple leaves and causing rust. Ammoniacal copper carbonate, sprayed twice (May 17 and 30) on a badly infested tree proved beneficial. The leaves on unsprayed trees had nearly all fallen in August and the apples were few, small and valueless; the sprayed tree, while not healthy looking, kept its

leaves and ripened about two barrels of good apples. The next year the red cedars were all cut out of the orchard and for a mile radius round about. The result was magical. In former years many of the apple trees were entirely defoliated by rust in August. This past summer not a rusted leaf was found in the entire orchard. The moral is plain. From the scientific standpoint the result is interesting as indicating that the mycelium of this fungus is not perennial in the apple and that the occurrence of the rust in the apple is dependent upon annual reinfection from the red cedars.

Brown rot of plums. A malady due to a fungus (*Monilia fructigena*) propagated from year to year in the mummied plums which remain over winter. To combat it, rotting fruit should be promptly removed and burned or buried. Plowing helps to turn under the spores. Spraying the limbs and trunks before the buds swell with copper sulphate solution (1 lb. in 16 gallons water) is recommended. Ten to 25% of the plum and cherry crops of 1905 were killed.

Oat smut. The causes and remedies of this malady were discussed annually from 1890 to 1896. The applicability of the Jensen hot water treatment for the disinfection of seed oats (soaking at 128° F. for 15 minutes or 133° F. for 10 minutes) was demonstrated. Increased yield following the soaking of the seed was not a constant occurrence, the yield being in some cases depressed. The relationship between source of seed and its smuttiness was demonstrated, the Vermont grown seed as compared with that originating in the West being relatively free from smut. The following table is illuminating:

1892—47 fields	Vermont seed.....	0 to 6.3%	average 1 % smut
20 fields	Western seed.....	0.2 to 7.4%	average 3.1% smut
1893—66 fields	Vermont seed.....	0 to 2.8%	average 0.6% smut
20 fields	Western seed.....	0 to 7. %	average 1.6% smut

Not enough smut appears as a rule in native grown seed to necessitate disinfection; but if Western seed is used it pays, since at least 3 to 4% gain per year for several years is entailed, for smut once killed stays killed, if new infection is not introduced.

A soft rot of carrot and other vegetables. An extended study of the occurrence and character of the disease, its pathogenesis, the morphological and physiological characters of the causal organism (*Bacillus carotovorus*, Jones), and of remedial measures.

The malady—a rapid softening rot—was reported from several points and found due to a hitherto undescribed bacterium. The dis-

organization of the tissues seems due to an enzym which softens the middle lamellae. Many forms of vegetable life are susceptible when wounded, others are not. No infection occurs unless the epidermis is broken. The decay is similar in all cases, viz.: a rapid tissue softening and a liquid exudate clouded with bacteria. The bacillus, single in old, and in chains in younger cultures, with flagelae, motile, non-sporulating (so far as observed) was grown on the usual and on certain special media, and exhibited cultural characters which were recorded, as were also its bio-chemical relations.

Remedial measures recommended were: crop rotation, non-use of manures, the desiccation of root surfaces, their exposure to sunlight, and a low temperature storage room.

Club root and black rot of cabbage and turnip. These destructive diseases of the cabbage, turnip and allied plants threaten to become widespread in Vermont, yet are easily suppressed if taken in season.

Club root, a curious malformation which ruins the plants by preventing the absorption of water and food, was introduced from Europe and is spreading. It has been observed in Vermont but recently. The clubbing of roots is due to their invasion by a parasite which stimulates them to abnormal growth. Once established in the soil, it is very difficult to exterminate. It is perpetuated over winter by spores which form in vast numbers in the clubbed roots. They pass uninjured into the manure of stock fed upon clubbed roots. Such infected manure serves to introduce the germs into the soil, as does also the transplantation of roots from infested soil, where it may live for years. The disease attacks numerous plants of the mustard family, including various common garden vegetables, flowers and weeds.

Remedial measures. (1) Remove all clubbed roots from the field and burn or bury them; if fed to stock, boil them; (2) plow infected soil deeply; (3) rotate crops; (4) suppress all weeds of the mustard family; (5) apply lime, 75-100 bushels per acre, in autumn before planting cabbages or turnips.

Black rot of cabbages, etc., a recently recognized disease, has been observed in numerous Vermont fields. It is caused by bacteria which invade leaves and stem. The diseased plants are weakened or die of a sort of dry rot. The blackened condition of the invaded veins is the surest sign of the disease. It is not to be confused with the common wet rot. The germs pass the winter in the soil, or in the manure if the diseased plants are fed to stock. They re-enter the cabbage plants through the water pores or insect punctures.

Remedial measures. (1) Rotation of crops; (2) care in use of manure; (3) suppression of cabbage insects; (4) removal and destruction of spotted leaves or of entire plants.

THE DAMPING OFF OF CONIFEROUS SEEDLINGS

L. R. JONES

This malady is a serious hindrance to success in rearing seedlings of pine or other conifers in the nursery. It appeared in the station beds in 1906 and again in 1907, and was restricted to the early stages of development immediately following germination. Soon after the plants appeared above ground the stem tissues browned and shrivelled at or below the level of the soil and the weakened plants fell over and wilted. The diseased tissues were permeated by fungus mycelium. Evidently there is a critical period in the early stage of development of coniferous seedlings when the tissues are unusually susceptible to parasitic invasion.

European publications indicate that more than one fungus may cause this disease. The development of the disease is apparently conditioned upon three things:

1. Conditions of temperature and moisture as determined by the weather and the mode of handling the shades on the seed beds, etc., during the critical period.

2. Previous treatment of the soil, which may tend to increase or diminish its fungus content.

3. The use of fungicides or other applications upon the beds during the critical period.

Much can be done to control this disease by proper management of the beds during the critical period. It is necessary to keep the beds covered in some way until germination begins, but the covering should be removed promptly thereafter, to prevent slender weakly development. Partial shade is required on bright days, but this should be removed in dull or wet weather to keep the surface soil of the beds from remaining too wet. These are matters of personal judgment and experience, of special importance if warm rainy weather occurs during the critical period, when the surface of the beds must be kept as dry as practicable.

The fungus content of the soil at the time of planting is an important factor; hence the practicability of disinfecting seed-bed soil is worth consideration. In greenhouse work, soils are advantageously sterilized by steam. This is apparently impracticable out of doors.

Recourse was therefore had to the trial of chemicals and formalin was chosen as of most promise. At the outset the formalin affected the germination injuriously. The one-half percent formalin solution reduced the germination of the stand 25 percent, and the one percent formalin reduced it by nearly 50 percent. Within a few days, however, conditions began to alter. Those pine seedlings which started made as rapid growth in the treated as in the untreated soil. Where no formalin was used damping off soon set in and at the season's end 90% had perished. In the treated compartment some loss occurred, but it was much less, amounting to only 9% where the one-half percent formalin was used and 7½% where the one percent formalin was used. This outcome encourages the hope that with further trials, using other strengths of formalin and with a longer period between its application and the sowing of the seed, still better practical results may be secured. The possibility of control of the disease in the beds by the application of fungicides during the critical period following germination is studied, but has not as yet passed the experimental stage.

One procedure is, however, certainly commendable, the sprinkling of hot sand on or over the beds immediately following germination. The gains were not large, but sufficient benefit was derived to pay well for the application. Since it is a simple, safe and inexpensive proceeding, it is deemed worth while. Clean sand is used, preferably of coarse texture, and applied as hot as it can be handled, sprinkled on immediately after germination, enough to fully cover the surface of the bed, say one-sixteenth of an inch in depth.

WEEDS

Orange hawkweed or paint-brush (*Hieracium aurantiacum*). A survey of the status of this weed in Vermont, together with special experimentation, led to the statement that it was the worst weed known in certain portions of Vermont, threatening to invade other sections unless precautions are taken.

It is easily recognized by its peculiar hairy leaves and stem and its conspicuous orange-red blossoms. It is a native of mountainous Europe and was introduced as a garden flower. It became well established here since 1870 and has spread most actively since 1880, being most troublesome in the northwestern counties. It rapidly adapts itself to varying conditions and thrives on all soils and at all altitudes. It is a perennial and propagates rapidly both by runners and by seeds. It is most troublesome in permanent grass lands, such as lawns, roadsides and hill pastures. It is extremely difficult to get rid

of it when thoroughly established in the pasture. It may be subdued by clean culture where practicable and is quickly killed by salt.

The shrubby cinquefoil (*Potentilla fruticosa*) is widely distributed in the north temperate zone. It is usually a botanical rarity, but in certain sections of southwestern Vermont is "the most aggressive weed invader known, taking almost complete possession of the pastures and pushing even into tilled lands." The plant passes under many local names, grows 1 to 5 feet high, is a pleasing shrub used in ornamental plantings, and propagates as a weed by a great abundance of seeds, which are scattered by the wind like the dandelion, and by sprouting freely from the crown if cut back. Its only serious weed development is in a belt extending from northwest Connecticut through western Berkshire County, Mass., into Bennington and Rutland Counties, on calcareous soils. It has no economic value.

No easy method of combatting it is known. Heavy stocking of pastures recently invaded serves to control it. When fields are completely occupied, burning tops is thought to do little permanent good, nor will mowing do better. Plowing with grubbing and pulling out the larger stools works well, but costs for a well infested area from $8 to $24 per acre. Cattle and sheep browse it somewhat, but will not steadily eat it. Angora goats—used by the station in its experimental fight against this weed—did better and on the whole were effective. Reforestation seems the best solution for thoroughly infested areas, since the pest is killed quickly by tree growth of any kind. It yields but slowly to white pine, fairly to willows and remarkably to butternuts. There seems to be some peculiar root antagonism between the two plants. Wherever butternut trees occur each large tree occupies the center of a clean grassy circle of a diameter considerably exceeding the farthest spread of its branches, while the bases of rapidly growing young trees form the center of an area of dead and dying cinquefoil plants. The butternut should be accorded prominence in reforestation schemes looking to cinquefoil extermination. One young butternut per square rod would probably in ten years kill most of the cinquefoil.

Killing weeds with chemicals.—Gravel walks, etc. Gravel walks, drives, tennis courts and similar places can be kept free from weeds by the use of certain chemicals. The worth of a chemical for such purpose depends on its immediate action as a herbicide and the persistence of its effect. A single application each year should suffice with a good herbicide. The arsenical compounds proved far superior to copper sulphate, potassium sulphid, kerosene, carbolic acid, or sulphuric acid.

The arsenical compounds tested, named in the order of their merit, were: Henderson's fluid weed destroyer, arseniate of soda; Smith's weed killer, arsenic-sal soda mixture. The chief difference between them lay in the persistence of their effect, but all of them endure for one year or longer. Cost, convenience and effectiveness are factors in choice. Using eight gallons to the square rod, they cost per square rod, 40 (Henderson), 11 (arseniate) and 8 (arsenic-sal soda) cents. Henderson's fluid is most convenient to use; arseniate of soda is scarcely less so; arsenic-sal soda mixture is somewhat inconvenient to prepare. While each was effective they may be rated as to endurance: first, Henderson's; second, arseniate of soda; third, arsenic-sal soda. For small areas, in places where cost is a minor item, Henderson's weed destroyer is recommended; for larger areas, arseniate of soda; for very large areas, arsenic-sal soda mixture is enough cheaper to make its use profitable.

Lawns. The coarser and deeper rooted perennials (dandelion, plantain, white daisy, docks) are best combatted by frequent spudding and close mowings, accompanied by proper fertilization, watering and abundant seeding with lawn grass. Shallow rooted creeping plants (hawkweed, crab grass, chick weed) are not thus to be handled. Salt applied at a dry time works well with hawkweed and with chickweed (2 quarts per square rod for latter), the latter when wilted to be thoroughly raked out and liberal amounts of grass seed raked in. Crab grass cannot be easily exterminated. A little may be weeded out; more may in part be got rid of by raking the prostrate seed stalks high enough before mowing to insure the lawn mower cutting them, a practice, which, repeated during late summer and autumn, prevents seed maturation and lessens the extent of the trouble. Reseeding with clean seed with much white clover is suggested.

Kale killing in oats or other cereal crops. Charlock (*Brassica sinapistrum*) can be destroyed by spraying with weak copper sulphate (1 pound to 4 gallons water if flower stalks have appeared, 1 pound to 6 gallons if younger) at the rate of 30 to 60 gallons per acre. The cereal crops are but slightly injured. "Wild turnip" (*B. campestris*) is more resistant. Not over one-half of the sprayed plants were killed. The expense, save of labor, is small and the operation may prove profitable. One should know what kind of kale he has to fight before spraying, for it is doubtful if it is a paying proposition thus to combat the wild turnip.

Killing hawkweed or paint-brush (*Hieracium aurantiacum*). Salt kills hawkweed by drawing water from its tissues. It should be

applied dry (not as a brine) upon a hot, sunshiny day, preferably during a period of dry weather, scattering it uniformly, broadcast, so as to come in contact with all the leaves, using from 12 to 18 pounds to the square rod. This application has killed hawkweed and increased the grass crop. The use of salt is recommended only for isolated patches or in soil where cultivation is impracticable. Refuse salt suitable for the purpose costs from $4 to $5.50 per ton. The quick and complete destruction of the weed, even in small patches, is important to prevent its wider spread. Sulphuric acid was tried, but without success.

Impurities in grass and clover seed. Three studies of the grass and clover seed trade were made in 1898, 1900 and 1904. The summarized statements concerning the first two surveys are as follows:

Impurities in clover seed. Most of the newer seeds have been introduced in clover seed. Examinations of 34 samples showed that English plantain, sheep sorrel and wild carrot seed were often and dodder occasionally present. These samples represented the better grades of seed; the lower grades were far fouler than these. A legal enactment requiring a guaranty of freedom from certain weeds is suggested.

Impurities in grass and clover seed. Many farmers pay high prices for pigweed, purslane, kale, plantain and the like, buying them for grass and clover. Clean timothy is purchasable. It is largely a matter of price. Not so with clover, however, since high price does not insure pure seed. Such seed should receive critical examination and be bought discriminatingly.

The third study involved the determination of purity and germination of 735 samples, including 222 timothys, 83 red tops, 103 millets, 134 red and 105 alsike clovers, the investigation being one of the most exhaustive ever made in the United States. The chief evils were:

1. Much inert foreign matter, dirt, chaff.
2. The occurrence of weed seeds.
3. The occurrence of foreign non-weed seeds: (a) legitimate impurities, such as timothy in alsike; alsike in red clover, etc.; (b) adulteration or substitution; yellow trefoil for alfalfa or clover; fescue for orchard grass, etc.
4. Low germination, either: (a) moderately low, due to cheap seed; (b) very low, due to age.

Recommendations are made as to the advisability of more careful seed inspection by farmers for themselves (methods and simple apparatus being suggested) or by the Station for them on request; and

as to the wisdom of legislation, citing the nature of laws in other states and quoting the successful Maine law.

SEASONAL INFLUENCE IN CARNATION CROSSING RELATIVE TO SEED PRODUCTION

WILLIAM STUART

During the past four seasons the writer has studied the seasonal influence in carnation crossing on seed production. Owing to the fact that but a limited portion of the station greenhouse could be devoted to carnations, the number of plants upon which crosses could be made in any season was relatively small. With few exceptions all data secured during the several seasons shows a fairly uniform decrease in seed production and viability of seeds as the season advances. The condensed results are presented below in tabular and in graphic form in connection with similar data reported by Rudd:

COMPARISON OF RESULTS BY RUDD AND BY STUART

		Crosses made in			
		Nov.	Dec.	Jan.	Feb.
Percentage of successes	Rudd	66.	53.7	44.7	35.
	Stuart	83.3	68.1	60.8	73.7
Average number seedlings per capsule	Rudd	15.5	7.8	6.4	4.6
	Stuart	24.3	19.	13.7	10.9

GRAPHIC REPRESENTATION OF AVERAGE NUMBER SEEDS PER CAPSULE

SUMMARY

Early crosses seem to give on the average:

1. A considerably higher percentage of successes.
2. A much larger number of seeds per capsule.
3. A higher percent of germination.
4. Heavier seeds (although the latter generalization is not insisted on, as the data at hand are not sufficiently ample).

The probable reason why better results are secured from early crosses seems to the writer less due to seasonal influence than to the greater vigor of the plants.

THE MONTREAL MARKET MUSKMELON INDUSTRY

WILLIAM STUART

For years a few Canadian growers of this melon have enjoyed an almost exclusive control of the large eastern markets of the United States. These growers, through carefully selected stock and skilful cultural methods, succeed in supplying excellent melons at fancy prices ($8-15 per dozen wholesale). The crop, however, is an expensive and precarious one to grow, owing to frequent recurrence of unfavorable seasons, and to the extreme care required to grow it successfully.

CULTURAL METHODS

The cultural methods employed by Montreal growers are essentially as follows: The seed is sown in the greenhouse or hotbed from late February to early April; later they are potted up into three or four inch pots, and when in danger of suffering for lack of root space and plant food and the weather is favorable they are removed to sash-covered frames, there to remain until they are almost fully grown. These hotbeds are well constructed, well exposed to the sun, and also protected from cold winds. The frames are often covered with two sets of sash, mats, and board shutters. With such protection, if horse manure is used to generate a sufficient bottom heat and the exposed portions of the frame are banked therewith, the plants may be grown almost as well as in a greenhouse. These frames are moveable sections approximately 12x6, strong and tight with tie rails for the sash to slide upon.

The soil over which these sections are set is ridged up in beds 12-16 feet wide with a one foot center elevation. A trench is dug 2 feet wide, 15-18 inches deep, and filled almost level with well fermenting manure, and a portion of the surface soil thrown over it, slightly more being drawn in where the plants are to be set. The frames are then set in place and covered with sash, which in turn are further reinforced with mats and wooden shutters, or hay or straw with or without the shutters. A 4-6 foot space is allowed between the ends of each section. When the soil over the manure is well warmed up, the warmest portion of some favorable day is selected for planting. Great care is exercised now in transferring the plants from the hotbeds to guard against setbacks from sudden changes of temperature or soil conditions. The coddling process does not cease now. It is simply spread over a greater area and the plants require even closer care than before, for greater attention must be paid to watering,

syringing and ventilation, success at this stage being very largely dependent thereon.

As the fruit attains size, it is usually lifted from the soil by a shingle or flat stone, to avoid loss from cracking, rot, etc. Uniform shape, color, netting and ripening is secured by turning the fruit every few days. When the runners fairly occupy the enclosed area the frames are raised a few inches. As the season advances more and more air is admitted until, finally, when the melons are almost full grown, the sash and then the frames themselves are entirely removed.

As each fruit sets its shoot is pinched off one or two joints beyond it. A 15-20 melon crop is considered sufficient from each 6x12 frame. Three or four hills are planted and usually two plants are set per hill.

The melons vary greatly in size. One weighing 44 pounds has been grown. The writer saw one weighing 22 pounds which had been selected for seed purposes. Their average weight range from 8 to 15 pounds, and a dozen averages from 120 to 130 pounds. In exceptional cases some have been shipped weighing 240 pounds per dozen package. The larger melons are apt to be poorer in quality than those weighing 8-15 pounds.

Two distinct types exist, a roundish oblate and an oblong, the first slightly deeper ribbed than the latter. These do not seem to be separated by the growers. It is not at all certain that either type is fixed.

A large wicker basket (clothes basket) is commonly employed in shipping to distant markets. They hold a dozen melons, packed in short fine-stemmed hay, and are shipped without cover, no attempt being made to fasten the melons in place, the express company being held responsible for safe delivery.

A first hand study of this industry leads one to query as to the causes or reasons for the monopoly possessed by Montreal gardeners. American growers have tried to produce the crop, but apparently without continuous success. At any rate American grown melons of this variety cut no figure in the eastern markets. Yet no valid reason appears why American growers should not succeed. Hence the following work was undertaken:

Cooperative work was undertaken with Mr. E. S. Brigham of St. Albans, seed secured from a Montreal grower and sown in the station greenhouse on April 12. Duplicate plantings by Mr. Brigham were made in berry baskets plunged in a hotbed and filled with a rich friable soil. Early in May the plants were shifted into four inch pots and, on May 24 were planted out at St. Albans. Owing to lack of good fermenting manure no bottom heat was supplied; but an abundant dress-

ing of well decomposed manure was used and the frames covered with sash. Owing to the lateness of the season it was thought unnecessary to cover the sash with mats, yet on the night of May 24 the mercury registered 28° F., and the weather during the next few weeks was unseasonably cool. This low temperature, coupled with lack of bottom heat and of mats, severely chilled all portions of the vines near the glass. Growth was materially checked during this prolonged period of cool and cloudy weather, and the setback was never fully overcome.

The warmer weather of latter June entailed a fairly satisfactory growth. By July 30 some of the larger melons were beginning to net. The first ripe fruit was picked August 19, and from that period on several were harvested, mostly much undersized, weighing less than 8 pounds; some of good quality, others distinctly inferior.

The removal of the sash in late August and the heavy rains of early September induced rapid growth and much cracking of both skin and flesh, thus affording favorable opportunity for disease. And on September 12 a few melons were found seriously affected by a soft rot, and two days later a large share of the fruit was found thus affected. The primary points of infection seemed to be those parts which were in contact with the soil or the object on which they were superimposed. Had they been turned frequently during the rainy period less loss would have occurred. The frequent and heavy September rains and cool weather favored the development of this disease and lowered the quality of the healthy melons and retarded the ripening period. Few really good fruit were secured after September 15.

SUMMARY

The Montreal grower succeeds only through the careful observance of the best cultural conditions. His success is, however, directly dependent on the weather conditions obtaining during the growing season. Cold, wet weather during the ripening period materially injures quality and retards ripening. Successional plantings, the first ones in late February or early March, extends the ripening period from mid-July to frost.

A crop which may net $1,000-$2,000 per acre is worth an effort to produce.

Canadian growers seem unable to supply the American demand, even at $10 to $15 per dozen wholesale.

The experimental work at St. Albans was not successful. However, the knowledge secured in the handling of the crop justifies the assumption that there is no valid excuse for continuous failure on the part of American growers to produce these melons successfully. And

to the end that a clearer idea of the reasons underlying success and failure may be attained, further work along these lines is contemplated.

MOISTURE AND DECAY LOSS OF HUBBARD SQUASH IN STORAGE

WM. STUART

There is practically no literature upon the subject of moisture and decay loss of stored vegetables. The extent of this loss varies inversely with the conditions of harvest and storage. Different classes of vegetables under identical conditions of storage show widely varying percentages of loss.

The winter storage of vegetables may prove profitable or not according to varying circumstances. Controlling factors are:

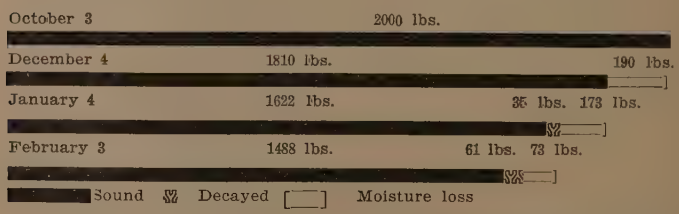
(a) The loss in weight.

(b) The cost of storage, interest charges, etc.

(c) The increase in sales price over that ruling at harvest.

In order to determine the loss sustained in storing Hubbard squash till mid-winter, a ton weighed as taken from the field, was stored on October 3 in a dry and medium warm (50-60°) room. On December 4 it weighed 1,810 pounds, a moisture loss for two months of 9.5 percent. On January 4 it weighed 1,657 pounds, (sound 1,622, decayed 35). A moisture loss of 8.5 percent and a decay loss of 1.8 percent. On February 3, four months from the harvest, the sound squash weighed 1,488 pounds and the decayed, 61 pounds, a moisture loss of 4.5 percent and a decay loss of 3 percent. The total moisture loss during four months was 20.8 percent and that from decay 4.8 percent; total, 25.6 percent.

MOISTURE AND DECAY LOSS OF HUBBARD SQUASH IN STORAGE



Gain or loss from storage.—When the squash were put in storage they were wholesaling at a cent per pound; late in October at 1.5 cents, 2 cents late in December, and in January, owing to unusual scarcity, at 2.5 to 3 cents. At the conclusion of the trial the 1,488 pounds were

sold for $53, an average of over 3½ cents per pound, the net gain by storage being $33 per ton. Market conditions, however, were very unusual. The common price at harvest is $15-$20 per ton, and does not materially increase until January ($30-$40), while during February and March they advance to $50. Hence, even under ordinary conditions the increase in price amply offsets losses from moisture, decay, and cost of storage and leaves a handsome profit.

Conditions insuring minimum loss in storage.—To minimize storage losses:

(1) The squash should be well matured before harvest.

(2) They should be cut or carefully broken from the vine, leaving the stem attached to the squash.

(3) If possible, they should be placed in small piles to ripen and harden up for two or three days before hauling from the field.

(4) They should be hauled in a spring wagon, the box of which is lined with burlap or other material to prevent bruising.

(5) The storage room should be dry and moderately warm at least for the first two weeks to harden up the shells, after which a lower temperature, provided the room is dry, may be maintained.

(6) Finally, squash from harvest to sale should be handled as one would handle eggs. Broken stems and bruised skin are sure to cause decay.

Summary.—Squashes properly grown and handled may be held in storage till midwinter or later with a reasonable assurance that the moisture and decay loss will be amply covered by the increased price received.

HORTICULTURE

Apple growing in Grand Isle County. A survey of this industry made in 1896 led to the following statement: Grand Isle County is increasingly devoted to commercial apple growing, and the success already achieved encourages its further extension. The crop of 1896 has been larger than in any previous one (40,424 barrels of marketable apples). The number of bearing trees is 34,885; and of trees still too young to bear, 17,229. Sandy or gravelly soils are preferred; budded nursery stock, two to three years old used, though some prefer native or hardy stock and top grafting; all commercial orchards are systematically cultivated; barnyard manure is used; windbreaks are found valuable; spraying is an accepted practice, apparatus and methods varying; and top grafting is frequently practiced. The fa-

vorite varieties grown are Northern Spy, Rhode Island Greening, Baldwin, Fameuse, Talman's Sweet, Pound Sweet, Golden Russet, Ben Davis, Yellow Belleflower and Arctic. They are picked directly into barrels and usually sent to market early, though some are held in storage.

A further and more systematic survey was made in 1901 with several objects in view. (1) to make a complete inventory of all varieties; (2) to examine specimens and discover whether or not they were as represented; (3) to name unknown apples or those grown under incorrect names; (4) to determine what varieties were best to plant; (5) to discover varieties of local origin, distribution and reputation; (6) to determine the origin of the various varieties; (7) to determine the varieties which maintained themselves continuously for years and to obtain the history of those which have succeeded or failed as a contribution to the study of the working of the laws which underlie plant distribution.

Grand Isle County is a most favorable district for a study of such problems. It is made up entirely of islands and one large peninsula in Lake Champlain, and the entire county is set off from its neighbors. Its people have always lived at home among themselves to an unusual degree. It was opened to railroad communication in 1901.

The best apple market varieties grown are Rhode Island Greening, Fameuse, Northern Spy, Ben Davis, Baldwin. The various varieties are thus placed as to origin. (1) Many are the common apples of all New England and New York State; examples, Baldwin, Northern Spy, Rhode Island Greening. (2) some derived from the vicinity of Boston; examples, Jacob Sweet, Harvey and Hawley. (3) some are derived from the lower Hudson valley, more particularly through the Downings; examples, Peck's Pleasant, Newton, Pippin, Spitzenburg and Grimes. (4) the Province of Quebec; examples, Fameuse, Pommene, Grise. (5) several have come in as a result of the survey for commercial varieties for cold and exposed situations, more particularly through the efforts of Dr. T. H. Hoskins of Newport; examples, Longfield, Scott, MacMahon, Yellow Transparent, Wealthy. (6) "the hustling, modern fruit tree agent"; examples, Beach, Stark, Legal Tender, Arctic, Fishkill.

Two separate apple planting movements were noted, one by the original settlers planting haphazard varieties, the other the planting of orchards for profit. The latter movement had two distinct phases: (1) the planting of commercial varieties, no matter of what kind; (2) the adoption of the strictly commercial sorts. Twenty-eight pages

of apple notes and descriptions are given in the text, listing 116 varieties with many synonyms.

Apple growing in Addison County. A survey of the number of bearing trees in 1901, of the crops of 1900 and 1901, with statistics as to orchard culture, the use of the wind breaks, the soils used, the varieties grown, and practical suggestions as to soil cultivation, fertilization, spraying, pruning, varieties and marketing. It was shown that but one-fifth of the growers cultivated their orchards; that about one in four used fertilizer; that only 4 out of 40 representative growers sprayed their crops, and that but five or six orchards were guarded by wind breaks. A long list of varieties were found growing, the most popular being the Greening, Baldwin, Northern Spy and Fameuse.

Pollination of apples. Apples are often self-sterile, and need cross-pollination. In trials made by this station practically all the varieties tested proved self-sterile, including such common sorts as Baldwin, Fameuse, Esopus, Northern Spy, etc. In order to secure cross-pollination of two varieties care must be taken to select such as blossom at the same time. Bees are the chief agents in pollen transfer. The wind does not transport the pollen to an appreciable extent.

Apples of the Fameuse type. A survey of the Fameuse type, its essential variation and pomological status, with discussion and notes of sundry varieties. Fameuse is the type of the Fameuse group, which includes several other varieties closely resembling it, such as McIntosh, Shiawassee, etc. The Fameuse type is of great commercial importance. It has many marked good qualities and few defects. Fameuse has had a long and interesting history. It probably originated in the 1600's in the French settlements on the St. Lawrence, was distributed widely, though chiefly by seeds, and was first planted in Vermont at Chimney Point about 1700. Fameuse varies greatly, largely because propagated by seed, and partly because of bud variation. There are several important varieties of this type, while hundreds of other seedlings, recognized as of the same group, have not been generally propagated.

Hardy apples for cold climates. The limit of successful apple culture is moving steadily northward. Factors in this progress have been the crab apples, dwarf apples, the Russian varieties, the selection of native hardy seedlings and the adoption of better orchard practice. The present limit of the Baldwin and the Rhode Island Greening in Vermont is shown by a map. To grow a given variety further north a protected situation with a favorable exposure should be chosen and

top grafting done upon a very hardy variety growing on its own roots. Varieties recommended where hardiness is important are: Yellow Transparent, Red Astrachan, Longfield, Oldenburg, Fameuse, McIntosh, Wealthy, Scott Winter, Pewaukee, Arctic.

Bridge-grafting a girdled apple tree. Bridge-grafting is the only way surely to save badly girdled trees, and in most cases is a comparatively simple process. Where not completely girdled, mounding soil over the injured portion to exclude air and keep the wounds moist, will often serve to repair the injury.

On the winter injury of apple trees. In cases of winter injury like that experienced in 1904 there is little to be gained by the hasty removal of the greater portion of the head of the tree. In other words, severe pruning is inadvisable and probably more often injurious than beneficial. Pruning operations under such circumstances are better deferred until late in the growing season or until the next spring. Winter injury may be avoided by keeping the tree in a thrifty, vigorous condition. Weak, unhealthy trees are less able to stand extremes of temperature than thrifty ones.

Notes on the winter killing of twigs and buds. A discussion of the anatomy of twigs as related to hardiness, relation between dessication and winter-killing, and between maturity and winter-killing, with remarks as to heat absorption or reflection. It is held that (a) the inherent power of cold-resistance possessed by the plant; (b) the maturity of the wood, and (c) the dryness of the soil and atmosphere, with many minor causes cooperating are factors in the result.

Hardiness of plums. "A general study of the hardiness of the different species of plums in the United States has resulted in the fairly close determination of the northern limits of successful cultivation of typical varieties such as the Lombard and Bradshaw (European), Burbank and Kelsey (Japanese), and of the Wildgoose, Miner and Chicasaw groups. The Americana plums are found to be hardy as far north as any fruit trees can be grown."

Field notes on cherries. Explanatory statements as to varieties, descriptive, historical and nomenclatural. A memoranda of desirable varieties, with suggestions as to culture, soil cultivation, pruning, stocks, hardiness, diseases and insects, picking, marketing, etc. The following are recommended: Morello, Montmorency, Brusseler, Braun, Wragg, Bessarabian, Schatten Amarelle, Griotte du Nord, Juneat Amarelle. "There is a ready and profitable home market in Vermont for twenty-five times the quantity of cherries now grown—and cherries are easier to grow than potatoes."

Home grown grapes in Vermont. Cultural memoranda and variety notes. Good grapes for home use may be easily grown in Vermont. A warm site must be chosen and the vines covered in the fall. The common horizontal arm system furnishes the best method of pruning and trellising. Summer pruning is practicable within narrow limits. Early varieties should be grown, and the fruit left on the vine as long as possible. Several leading varieties are described and the results of tests given. The following are recommended: Black, Moore's Early, Worden; red, Moyer, Brighton, Wyoming Red; white, Green Mountain.

A home fruit garden. A discussion of the inception, planting and caring of home fruit gardens with suggestions as to choice of location, soil preparation, methods of obtaining trees, setting, varieties for choice of apples, pears, plums, cherries, grapes, bush berries and strawberries, with remarks as to their cultivation, fertilization, pruning, and winter protection.

EXPERIMENTS IN DRUG PLANT CULTIVATION

S. C. HOOD

During the season 1993 to 1906, inclusive, the United States Department of Agriculture, with the cooperation of the Vermont Experiment Station, has carried on experiments in the cultivation of drug plants. This work was taken up for the purpose of finding out if it is possible to produce, with a fair profit, many of the crude drugs which are now brought to this country from foreign parts and also to bring under cultivation certain wild medicinal plants which are becoming scarce. The following table shows the importation of some of the more familiar drugs for the fiscal year ended June 30, 1905:

Opium and other poppy products	$2,352,593
Dandelion root	4,562
Digitalis leaves	3,600
Yellow dock root	7,500
Thyme oil	39,839
Mustard seed	189,894
Burdock root	4,000
Quackgrass root	12,500

As will be seen, many of these plants are common weeds in Vermont, while many others are imported from countries with a climate not much different from that of New England.

SUMMARY

The results of these experiments have shown:

1. That root drugs, such as burdock and yellow dock, can be grown on Vermont farms with a good margin of profit where the land is low priced.

2. That Seneca snakeroot can be cultivated and the supply of this important drug kept up, even though the wild supply is exhausted.

3. That certain plants, such as belladonna, will not mature during the short Vermont season.

4. That sage, digitalis, and lovage will not survive the winter in Vermont, even though they make good growth the first season.

5. That in view of the high price of labor in Vermont the culture of herbs, such as catnip, thyme, lobelia, pennyroyal, and of seed, such as caraway, fennel, and coriander, is not likely to prove profitable.

6. That at present the cultivation of poppies for the capsules and seed is not promising for Vermont, but that there may be a future for these for the direct production of morphine.

7. That the province of the plant breeder extends just as much to drug plants as to other economic plants. That the alkaloidal and oil content can apparently be increased as readily by selection and by the use of fertilizers as can the protein, starch, or sugar content; and that larger yields per acre can be obtained, also disease resisting types secured by simple selection.

INSECTS AND INSECTICIDES

Household pests. Brief descriptions of the buffalo or carpet beetle and of clothes moths. The following remedies are suggested: For the buffalo beetle, the use of rugs instead of carpets, tarred paper next to the floor, benzine poured upon the edge of the carpet, or corrosive sublimate solution upon the edge of the carpet, steaming the carpet, the use of benzine. Insect powder is said to have no value. For clothes moths: enclosure of clothes in tight paper bags before the moths begin to fly in May, the sprinkling or spraying of infested articles, drawers, etc., with benzine or with bisulphid of carbon.

Notes concerning sundry pests, including *Dermestes lardarius*, the red-legged ham beetle, ants, bedbugs, flea, house flies and mosquitoes, with remedies.

Insects injurious to the elm. Notes on mourning cloak butterfly, tussock moth, canker and fall canker worm, fall web worms, elm borers, elm leaf beetle, May beetle, June bug, plant lice, elm gall and cockscomb gall lice. Descriptions and in some cases life histories are given. Banding trees is suggested for tree canker worms, gathering and burning the webs for the fall web worms. Arsenical sprays are also effective. Digging for the borers is suggested, though not very effective. Arsenicals, kerosene emulsion and carbolic acid solutions are advised for use against plant lice.

The round-headed apple tree borer. Historical and descriptive notes, together with preventative measures. The exclusion by the means of heavy paper or fine wire screen is effective only when properly done. Repellants are of service only when persistently used, and at best do not insure absolute protection. Patent washes are apt to prove injurious to the trees. Digging out with knife and wire is effective, but laborious. Carbon bisulphid intelligently used may be serviceable, but is a dangerous remedy in careless hands.

The white grub. A survey of life history, including egg deposition, larva formation, the beetle, experiments as to destruction (fungi infestation, refrigeration, starvation, dessication, insecticides, ashes, bisulphid of carbon, kerosene emulsion, ants, frogs, sundry animals and birds, etc.)

Early spring applications of insecticides for the oyster-shell scale. Early spring applications do not serve to eradicate the scale. Summer treatment of infested trees with dilute kerosene emulsion, whale oil soap or tobacco infusions, soon after the young have hatched, is more effective.

The occurrence and distribution of San Jose scale in Vermont. The San Jose scale may rapidly increase despite the rigor of Vermont winters. Its wonderful reproductive powers make extermination a serious problem. The present restricted infected area makes feasible more drastic measures than are commonly employed. Orchardists should carefully scan the trees for scale and report suspected cases at once to the station. An orchardist whose trees are infested with oyster-shell scale may temporize, spray or destroy; but he who finds San Jose and fails to report it harbors a serious menace. Lime-sulphur wash applied in the early spring is the best known remedy. Commercial preparations ("Scalecide," "Target Brand" and the "Rex-Lime-Sulphur" washes) give fairly good satisfaction. Badly infested trees cannot be entirely freed by spraying and should be cut down and burned.

Bug death. Both "bug death" and "laurel green" have value as preventatives of insect injuries to potatoes. They were used in amounts far in excess of those recommended as practicable under commercial conditions. "Laurel green" destroyed the Colorado beetle and lessened the injury from the flea beetle, but the foliage was seriously poisoned by free arsenic. "Bug death" seemed to protect against both, since the vines "were kept in better condition than were any others except the bordeaux (treated) rows." "Bug death has real virtues and does not hurt the foliage." However, "bordeaux-paris green mixture is far superior to any other substance as yet tested as a combined insecticide and fungicide for potatoes."

Arsenicals used against miscellaneous insects. London purple, paris green and white arsenic (1 pound per 60 gallons water) used against aphis on apple trees were not entirely effective; used against tent caterpillar were usually effective; used against codling moth after the apples were as large as marbles and turned downwards, were of no service.

Analyses of insecticides. Analyses of arsenicals, "bug death," herbicide, "laurel green" and other proprietary materials. Laurel green consisted mainly of copper; bug death was found to be roughly three-fourths zinc oxid, one-eighth lead oxide, one-eighth iron and alumina oxides; "herbicide" proved to be a concentrated solution of some alkaline arsenite; green arsenite and paris green appeared to be the same thing.

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